**NATURAL RESOURCES CONSERVATION SERVICE**
**CONSERVATION PRACTICE STANDARD AND SPECIFICATION**

# WETLAND RESTORATION

**(acre)**
**CODE 657**

## DEFINITION

A rehabilitation of a drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the natural conditions to the extent possible.

## PURPOSE

- Restore hydric soil conditions, hydrologic conditions, and hydrophytic plant communities on wetlands that have been manipulated
- Restore wetland functions that occurred on the disturbed wetland site prior to modification
- Reestablish native vegetation
- Reduce downstream flooding
- Reduce streambank erosion
- Restore natural biological diversity

## CONDITIONS WHERE PRACTICE APPLIES

This practice applies to sites with hydric soils which were natural wetlands that have been previously degraded hydrologically and/or vegetatively.

This practice does not apply to a Conservation Practice Standard and Specification Constructed Wetland (656) intended to treat point and non-point sources of water pollution; Conservation Practice Standard and Specification Wetland Enhancement (659) intended to rehabilitate a degraded wetland where specific functions and/or values are enhanced beyond original conditions; or Conservation Practice Standard and Specification Wetland Creation (658) for creating a wetland on a site location which historically was not a wetland.

Where levees are a component of the restoration, this standard is applicable to:

a) structural heights of 6 feet or less (structural height is the difference in elevation between the lowest point on the levee top and the lowest elevation of the natural streambed at the downstream toe of the levee, except where crossing a gully or ditch.

b) embankment structures that are class "a", low hazard structures where failure will not cause significant damage downstream

**Embankments exceeding the above criteria will be designed in accordance with Conservation Practice Standard and Specification Pond (378).**

c) product of storage times effective fill height is less than 3,000

**Embankments exceeding the above criteria will be designed in accordance with NRCS Technical Release 60 - Earth Dams and Reservoirs.**

## CRITERIA

**General.** Complete the Wetland Planning Checklist, Appendix A, National Engineering Handbook (NEH), Part 650, Engineering Field Handbook (EFH), Chapter 13 - Wetland Restoration, Enhancement, or Creation or similar documentation (WRP pre-plan) and MO-CPA-52 "Environmental Analysis for Conservation Planning". The soil, hydrology, and vegetative characteristics existing on the site

and the contributing watershed shall be documented before restoration of the site.

Restoration sites will be located on hydric soils. If the hydric soil is covered by fill or sediment, the site must be capable of meeting hydric soil criteria or the fill and sediment must be removed.

Upon completion of the restoration the site will meet the current NRCS soil, hydrology, and vegetative criteria of a wetland.

Appropriate water rights including flowage easements shall be obtained prior to the start of restoration.

Develop a water surface profile to confirm that there is no offsite flooding due to wetland construction if: (1) A wetland restricts more than 30 percent of a floodplain or (2) A wetland constructed in a floodplain contains constructed levees over 3 feet tall (except where is crosses ditches). (Floodplains are low areas subject to flooding from time to time. Most floodplains are adjacent to streams or lakes although almost any area can flood under the right circumstances. The amount of land inundated by a flood depends on the flood's magnitude.)

Wetlands shall not be located where they create a hazard or nuisance to adjoining landowners.

Vegetative buffers shall be established on surrounding uplands to reduce the movement of sediment and soluble and sediment-attached substances carried by runoff.

All federal, state, and local water laws and regulations shall be followed. The landowner must obtain permits required by federal, state, and local laws and regulations prior to restoration.

Excessive nutrient, pesticide, or other pollutant inflows shall be controlled prior to site restoration. Examples of excessive inflows include direct runoff from a feedlot or other obvious pollution source(s), an actively eroding gully emptying into the site, or a poorly treated watershed that is contributing sediment and its associated pollutants**.**

**Hydrology Restoration.** Hydrologic conditions of the site are expressed as the volume of water stored, rate and timing of inflow and outflow, duration, frequency, and depth of flooding, ponding and/or saturation. Wetland hydrology should be restored as close as possible to its original condition before it was manipulated. As a minimum, the hydrologic soil condition must be able to support hydrophytic vegetation. Use a water budget to evaluate sites receiving no upland runoff, no floodwater (backwater), and no diverted or pumped water to assure the planned hydrologic conditions will exist and to minimize levee height.

**Fill or Sediment Removal.** Side slopes and wetland shape and size should approximate the original configuration. When this cannot be determined, excavated areas shall have the following characteristics; (1) Excavated side slopes shall be 6 (horizontal-H):1 (vertical-V) or flatter; (2) The wetland edge shall have an irregular shoreline; (3) A Maximum depth of 4 feet; and (4) When possible, place a minimum 25 feet wide vegetated buffer surrounding the excavated area.

**Subsurface Drain Removal or Destruction**

In areas where subsurface drains were used to remove surface water or soil saturation, the existing system shall be modified to restore the wetland hydrologic conditions. Review of drainage records, interviews, and site investigations will be needed to determine the extent of the existing system.

The effects of the subsurface drainage system may be eliminated by the following: (1) removing or rendering inoperable a portion of the drain at the downstream edge of the site; (2) modifying the drain with a water control device; or (3) installing non-perforated pipe through the wetland site.

The minimum length of drain to be removed or rendered inoperable is shown in Table 1.

All sand and gravel bedding and filtering material or other flow enhancing material will also be removed. The trench shall be filled and compacted to achieve a soil density equal to adjacent material.

Where levees will be constructed, all subsurface drains shall be removed starting at the minimum distance shown on Table 1 downstream of the levee centerline and extending an additional 15 feet upstream from the upstream toe of the levee.

Where surface water inlets are provided for wetland water level control, existing drains

downstream of the site shall be protected by flow control devices.

The water control structure will be attached to a non-perforated conduit that extends at least the minimum length specified in Table 1. The connections of the water control structure and non-perforated pipe will be watertight at the head created at the maximum pool level.

Disconnected subsurface drains downstream of the wetland shall have an end cap installed or shall be plugged on the upstream end to prevent soil from entering the drain.

**Table 1**

Minimum length of subsurface drain to be removed or rendered inoperable or minimum length of surface drain to be filled.

| Permeability[1] (inches per hour) | Soil Texture[1] | Minimum Distance[2] (feet) |
|---|---|---|
| Greater than 2.0 | Sand | 150 |
| 0.6 - 2.0 | Loam | 100 |
| Less than 0.6 | Clay | 25 |

1/ Texture and permeability are for the general profile. Where the permeability and texture vary throughout the profile, consider the type of drainage system and which layer(s) are critical. Standard values for permeability and texture for each soil map unit are in the Field Office Technical Guide.

2/ The length is measured parallel to the direction of the surface drain flow.

**Surface Drain Removal.** Where open channels were constructed to drain the wetland, the channel will be filled with earthfill or controlled with a grade stabilization structure to restore the wetland hydrologic conditions. A water control structure may be required to manage water levels for wetland operation and maintenance.

The channel may be blocked with earthfill without a flow control device where flow duration and rate will not cause erosion and head cutting. The minimum length of channel to be filled will be as shown in Table 1.

The side slopes of channel blocks shall be 6 (H):1(V) or flatter on the downstream side and on the wetland side. All fill shall be compacted to achieve the density of adjacent materials. The earthfill height shall be increased by at least 5 percent for settlement and foundation consolidation.

**Water Control Structure.** Water control structures will be used when it is desirable to control or manipulate the water level for operation and maintenance of the wetland at an elevation different than that caused by blocking the channel. Use Conservation Practice Standard Structure for Water Control (587).

The water control structure shall be designed and installed in a manner to prevent internal soil erosion (piping) through or around all appurtenances.

Water control structures will have the ability to drawdown wetland pools at a minimum rate of 1 inch over the pool area every 24 hours without causing any erosion or flooding problems. The structure must automatically regulate the pool to the desired elevation. For further details refer to EFH, Chapter 13.

Avoid placing a water control structure in an inside levee corner since debris tends to gather over structures and beaver problems may be severe.

**Levees.** An earth levee may be constructed to create a pool storage volume equal to that which existed prior to conversion of the site or larger in size. Levee criteria may be found in the **GENERAL LEVEE CRITERIA** section.

Immediately after construction and prior to holding water against the newly constructed levee the entire levee and spillway area shall have a protective vegetative cover established. Use Conservation Practice Standard Critical Area Planting (342) for seeding recommendations with the exception that Reed's canarygrass will not be used.

Generally, borrow of fill materials shall not be closer than a minimum of 30 feet of the front toe of the levee, except where the existing borrow channel approaches the water control structure. If possible, creative borrow that replicates natural wetlands such as old meandering stream channels, oxbows, or depressional wetland areas should be utilized.

Levees in riverine settings should be constructed with flooding considerations in mind. Levees need adequate slopes to accommodate overtopping, need to be constructed with a consistent elevation so as not to channel water in a particular area, and should be constructed higher in elevation for 30 to 100 feet on both sides of the water control structure for additional protection. Earth spillways should be placed in levees, which will allow water to back into wetland from the downstream end and not channel water through the wetland or allow headwater flooding, except where scouring is advantageous. Elevation differences between the floodway and the water control structure should be minimized. Earth spillways need to be placed in areas that do not channel floodwater against constructed levees or water control structures.

Care should be taken to design levees so that they do not restrict floodwater from entering a wetland when backwater flooding is a primary water source.

In some cases, it may be desirable to take borrow from the upper portions of the proposed pool so as to extend the pool outward and flatten the proposed pool to enhance management capability for migratory birds.

**Pipes for Embankments.** Where there is a prolonged low flow or a base flow, a pipe or stone spillway will be used.

The outlet section of pipes shall extend at least 1 foot beyond the toe of the downstream levee sideslope or to a safe outlet.

Pipes to handle base flows shall convey at least twice the base flow rate. The minimum pipe diameter shall be 12 inches to reduce risk of plugging due to debris and animals trapped in the pipe.

Use anti-seep collars as needed on structures with permanent marshes or areas where permanent water will be held against the levee. When structural levee height exceeds 6 feet the anti-seep requirements of Conservation Practice Standard and Specification Pond (378) Standard shall be met. For further details refer to EFH, Chapter 13.

Required principal spillway discharges are shown in Table 2. When the total drainage area to wetland pool area ratio is 3.0 or less, no floodrouting of the spillway is required. The principal spillway flow plus any detention storage must handle the design storm shown in Table 2 without flow through the earth spillway.

**Structure and Drain Protection.** All surface water inlet structures shall be equipped with trash racks to exclude debris.

**Vegetation.** The vegetation will be restored as close to the original natural plant community as the restored site conditions will allow.

Determination of the original plant community species and percent composition shall be based upon the reference wetlands of the type being restored or other suitable reference material.

Plantings, seedings, or other types of vegetative establishment will be comprised of native species that occur on the wetland type being restored.

In soils where seedbanks of desirable species exist or natural succession of selected species will begin to occur in less than five years, then natural regeneration will be allowed for re-vegetation. Specific guidelines that consider soil, seed source, and species will be developed. The topsoil from wetland excavated areas may be stockpiled and redistributed to maintain plant seedbanks.

If the site was predominantly herbaceous vegetation prior to modification and planting is necessary, then a minimum of two species adapted to the site will be planted. Use soils and site information to determine plants to use. Herbaceous vegetation may also be established by placing soil containing seed or tubers at a minimum depth of 4 inches over 50 percent of the site. Control of undesirable vegetation shall be addressed and carried out in the Operation and Maintenance Plan.

Plantings on previously woodland sites will include a minimum of three species, where appropriate, at least two of the species will be

hard mast producing species. Use Conservation Practice Standard and Specification (612) Tree/Shrub Establishment for planting and establishment methods. Plantings will be wildlife friendly species. If root pruned potted stock is used, plant at a minimum rate of 40 feet by 40 feet spacing (approximately 27 trees per acre). Plantings may be done in clumps, or on the contour to ensure species will have optimum depth and duration of inundation. Use (612) for all other planting recommendations. Three years after establishment, wooded restoration sites shall have at least 125 stems per acre (desirable species).

**GENERAL LEVEE CRITERIA**

**Top Width** – 10 feet minimum. Consider a wider top in overflow areas.

**Side Slopes** – 4 (horizontal - H):1 (vertical - V) or flatter, in non-overflow areas and 6:1 or flatter in overflow areas.

**Settlement** – The constructed height shall be increased by 5 percent when height is 3 feet or higher. Fills under 3 feet in height do not need any additional settlement added.

**Site Preparation** – Include a cutoff trench as needed to reduce seepage losses. Debris and vegetation must be removed from the embankment foundation area as well as topsoil stockpiled for later use.

**Earth Spillway** – The spillway shall act as a relief section in the levee to allow the pool to fill from backwater flooding before the levee overtops. The earth spillway will allow excess water to exit prior to tailwater retreating. The difference between the earth spillway elevation and normal full pool elevation should be minimized since the water control structure will handle only a small portion of the runoff. Evaluate reverse pool filling (from the downstream channel) using USGS Stream Flow Data. For further details refer to EFH, Chapter 13.

Design earth spillways according to criteria given in Table 2.

**CONSIDERATIONS**

The hydrology and vegetative characteristics of the site and its contributing watershed before alteration should be documented. This can be accomplished by review of drainage records, historic records, historical aerial photography, and site investigation. Vegetation can be determined from historic records or existing vegetation on similar soils on nearby sites.

Hydrologic conditions, including duration, depth and timing are primary factors in vegetation establishment. USGS Stream Flow Data can, in some locations, provide long term as well as short term flood data for the restoration site. The vegetation selected should be compatible with the planned hydrologic condition.

Wooded units may need special consideration.

The effect of any modification to the existing surface and/or subsurface drainage system on upstream and downstream landowners shall be evaluated. Upstream surface and subsurface drainage shall not be impacted unless appropriate permissions are obtained or mitigation measures are implemented.

Calculate a water budget to determine hydroperiod (seasonal variability of the inflow, outflow, and storage) and hydrologic regime (depth of flooding). Compare these estimates to a reference wetland. Document what (if any) water surface management is needed throughout a typical year and include this information into the Operation and Maintenance plan.

Consider planning deeper pools within portions of the wetland especially if the drainage area to pool area ratio exceeds 3:1. Pools over 3 feet in depth are usually considered "permanent open water". In regard to restoring old ox bows and creative borrow areas, some pools may be as much as 3 feet or deeper. Borrowing deeper than 18 inches is normally not recommended.

Nutrients and pesticides contained in surface and ground water, as well as accumulated sediments, may have an adverse effect on wetland vegetation. The nutrient and pesticide tolerance of the species planned should be considered where known nutrient and pesticide contamination exists.

This practice should be applied to sites that are adjacent to existing wetlands to increase wetland system complexity and diversity, decrease habitat fragmentation, and ensure

colonization of the site by wetland plants and animals.

Wetland hydrology should be restored to the greatest degree to maximize the site's functions and values. Wetlands should be linked by corridors whenever possible to enhance the wetland's use and colonization by the flora and fauna.

Sediment delivery to restored wetlands from surface water inflow should be reduced when low maintenance is required. This may be accomplished with watershed treatment, grassed or riparian filter areas, or sediment basins.

Levees and excavated slopes should be located and shaped in a manner that is compatible with the existing landscape. The higher the levee, the more it is likely to: (1) Be damaged by rodents; (2) Create offsite flood damage; and (3) Limit out of bank floodwater from entering the wetland (and thus reduce wetland hydrology).

Placement of earth spillways can determine type and amount of debris and sedimentation that will occur. Soil conditions must be suitable. Care should be taken to not overexcavate and thus expose a permeable strata that may drain the wetland pool area.

**PLANS AND SPECIFICATIONS**

Plans and specifications for this practice shall be prepared for each site. Plans and specifications shall be recorded using approved specification sheets, job sheets, technical notes, narrative documentation in the conservation plan, or other acceptable documentation.

NRCS staff is encouraged to work closely with the NRCS Biologist, MDC Biologist, or other wetland specialist in developing site specific plans and specifications.

Plans and specifications for installing structures for water control shall be in keeping with this standard and shall prescribe the requirements for applying the practice to achieve its intended purpose. The plan shall specify the location, grades, dimensions, materials, borrow areas as well as spoil areas (when applicable), hydraulic and structural requirements for the individual structure, and the timing or sequence of installation activities. Provisions must be made for necessary maintenance.

**OPERATION AND MAINTENANCE**

The purpose of operation and maintenance is to ensure that the practice functions as intended over time.

A plan for the operation, maintenance, and management of the area shall be developed and recorded using approved job sheets, technical notes, or other forms of acceptable documentation.

The plan shall include monitoring and management of the overall site, as well as structural and vegetative measures. Repair and upkeep of the practice (maintenance) shall be carried out as needed, such as repair or replacement of vegetative or structural components.

The following activities will be addressed in the plan:

(1) Timing and level setting of water control structures required for establishment of desired hydrologic conditions, wildlife benefits, or for management of vegetation

(2) Inspection schedule of levees and structures for damage assessment

(3) Depth of sediment accumulation allowed in pool area before removal required

(4) Management needed to maintain vegetation (disking, mowing, haying, burning, use of approved herbicides) including control of unwanted vegetation

**Caution: Herbicide applications in and around water must be labeled for the intended use. If part of the drainage area of a public water is for domestic use, no current pesticides are approved for use.**

(5) Acceptable uses and activities with timing and density restraints (e.g. grazing and haying). See Conservation Practice Standard and Specification Wetland Wildlife Habitat (644) or Shallow Water Management (646).

Biological control of undesirable plant species and pests (e.g., using predator or parasitic

species) shall be implemented where available and feasible.

Any use of fertilizers, mechanical treatments, prescribed burning, and pesticides and other chemicals shall not compromise the intended purpose of the shallow water or moist soil area.

**REFERENCES**

National Engineering Handbook, Part 650, NRCS Engineering Field Handbook, Chapter 6-Structures, and Chapter 13 – Wetland Restoration, Enhancement, and Creation.

Fish and Wildlife Leaflet 13, Waterfowl Management handbook, U.S. Fish and Wildlife Service, Washington D.C 8pp. Available on the Internet at http://www.mesc.usgs.gov.wmh. Default.htm.

Table 2

**Minimum Spillway Discharge Capacity**

| Location on Landscape | Drainage Area to Pool Area Ratio (Acre per Acre) | Principal Spillway Minimum Design Storm (24 hour duration) | Earth Spillway Minimum Design Storm (24 hour duration) | Freeboard and Settlement |
|---|---|---|---|---|
| Floodplain | 1:1 (No runoff into wetland pool) | Draw down wetland pool in 5 to 7 days (with boards pulled) Set earth spillway at permanent pool elevation | Size, if needed, for back water flooding | Maximum 0.5 feet between earth spillway and top of levee If levee height < 3.0 feet, no settlement, 5% of levee height if > 3.0 feet |
| | Between 1:1 and 3:1 (Drainage area includes pool area) | Remove 1 inch of water over the pool area every 24 hours (with boards in) and draw down 85% of total volume In 5 to 7 days (with boards pulled) Set earth spillway at principle spillway design flow depth (0.5 feet maximum above perm. Pool) | 2 year Or Size for back water flooding Whichever is greater | Maximum 0.5 feet between earth spillway and top of levee If levee height < 3.0 feet, no settlement, 5% of levee height if > 3.0 feet |
| | Greater than 3:1 | 2 year Set earth spillway at principle spillway design flow depth (0.5 feet maximum above perm. pool) | 5 year Or Size for back water flooding Whichever is greater | Maximum 0.5 feet between depth of flow in earth spillway and top of levee If levee height < 3.0 feet, no settlement, 5% of levee height if > 3.0 feet |
| Upland | | Use design criteria for Structure for Water Control (578) | | |

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**NATURAL RESOURCES CONSERVATION SERVICE**
**OPERATION AND MAINTENANCE**

**FOR**

# WETLAND RESTORATION

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A maintenance program shall be established by the land user, with needed assistance, to maintain the wetland restoration practices. This O & M material may also be used to maintain constructed wetlands (656), wetland creation (658), and wetland enhancement (659) project components.

1. Inspect water control structure to ensure it is not damaged and is operating properly. Remove any woody material, debris, or growing timber that is interfering with the efficient use of the water control structure.

2. Mow grass and weeds near any plastic pipe to reduce chance of fire damaging the pipe during vegetative maintenance.

3. Inspect vegetation in wetlands. Some treatment may be needed to control undesirable vegetation.

4. Repair water control structure and levee (levee) as soon as possible after damage is observed.

5. Reestablish vegetative cover on levee (levee) immediately where erosion has removed established seeding.

6. Maintain effective erosion control of the contributing watershed (drainage area) to prevent siltation and the resulting loss of capacity.

7. Inspect levees for damage from burrowing animals such as muskrats. Some rodent control may be required to remove the hazard.

Additional details:

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**NATURAL RESOURCES CONSERVATION SERVICE**
**MISSOURI CONSTRUCTION SPECIFICATION**

**FOR**

# WETLAND RESTORATION

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Use this construction specification for wetland restoration including the installation of water control structures.

Installation of conservation practices for wetland creation (658), wetland enhancement (659), and constructed wetland (656) may also use this construction specification.

## General

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution are minimized and held within legal limitations. Construction methods that enhance fish and wildlife will be used where practical. Trees stumps, and brush removed from the construction area may be piled for fish and wildlife habitat when approved by the landowner.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used. Contractor shall ensure that all state laws for buried utilities are met.

## Foundation preparation

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod and rubbish. A minimum 3 inches of topsoil and sod shall be stripped from foundation area or as determined by the Engineer. Existing ditch channels crossing the foundation area shall be sloped 4 (horizontal - H):1 (vertical - V) or flatter and made deeper and wider as necessary to remove unconsolidated sediment, stumps, roots, and other objectionable material and to accommodate compaction equipment.

## Excavation

To the extent needed, all suitable materials removed from the specified excavation shall be used in the construction of the earth levee. All spoil material not used in the earth levee shall be stockpiled at locations shown on the drawings or as otherwise approved by the engineer.

Borrow excavation shall be located not closer than 30 feet to the toe of the levee so as not to cause slope stability or seepage problems.

## Materials

Materials required and fabrication details shall be as specified on the drawings and as shown below.

Concrete and reinforcing steel shall conform to Construction Specification 750.

Rock riprap and bedding shall be sound, durable rock conforming to gradation shown on drawings. Geotextile may be used in lieu of riprap bedding. Metal, concrete blocks,

and drain materials shall be as shown on the drawings.

Treated lumber shall be No. 2 grade or better, pressure treated with 0.4 pounds per cubic foot of Copper Chromate Arsenate (CCA) or equivalent. All other lumber shall be as shown on drawings.

Water control structures shall conform to Missouri Construction Specification 587.

Geotextile fabric shall be non-woven, needle punched conforming to construction Specification 753, Geotextile.

Corrugated metal pipe shall conform to the requirements of ASTM (American Society of Testing and Materials) A760, A762, A885, B745, or B790 as appropriate. Plastic pipes through the levee shall be polyvinyl chloride pipe, PVC 1120 or 1220 conforming to ASTM D1785, ASTM D2241, AWWA C900 or equivalent. The SDR 35 PVC plastic pipe shall conform to ASTM D3034. The SDR or DR of PVC pipe shall be 35 or less for fill heights 10 feet or less. Corrugated PVC pipe with smooth interior shall conform to ASTM F949 with a minimum pipe stiffness of 46 pounds per square inch. Corrugated polyethylene heavy duty tubing with smooth interior wall and pipe stiffness of 45 pounds per square inch shall be used. Welded steel pipe shall be new and shall be pipe standard weight conforming to ASTM A53 or API (American Petroleum Institute) 5L or equivalent. Anti-seep collars when required shall be of materials compatible with the pipe.

**Installation**

Pipe conduits shall be placed on a firm foundation to the lines and grades shown on the drawings. The pipe foundation shall be covered with 1 inch of loose, moist, friable ML or CL soil material immediately prior to pipe placement.

Anti-seep collars when required are to be installed at locations shown on the drawings with watertight connections.

Selected backfill of friable ML or CL material shall be placed around structures, pipe conduits and anti-seep collars at approximately the same rate on all sides to prevent unequal pressures. Rubber tire, hand, or manually directed power tamper will be used on backfill around all conduits or structures. A maximum of 4 inch lifts shall be used for hand compaction and 6 inches lifts for rubber tired and manually directed power tampers. Extreme caution must be exercised in backfill and compaction around structures or conduits to prevent damage, movement, or deflection. Compaction on the bottom half of conduits must be firm to fill all voids and supply lateral support. Light weight conduits may need to be held in place to prevent uplift during compaction.

Equipment shall not be operated over any structure or conduit until there is sufficient backfill to prevent damage. This minimum cover is 3 feet for PVC pipe and 2 feet for welded steel pipe.

If coated CMP is to be used, it shall be handled in such manner as to avoid damage to the coating. All damaged areas of the pipe coating shall be repaired in accordance with the manufacturer's recommendations.

**Earthfill placement**

The material placed in the fill shall be free of detrimental amounts of sod, frozen soil, stone over 6 inches in diameter (except for rock fills) and other objectionable material. To the extent they are suitable, excavated materials are to be used in the permanent fill. The distribution, moisture content, and gradation of materials shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Foundation areas shall be kept free of standing water when fill is being placed on them.

The placing and spreading of the fill shall be started at the lowest point of the foundation and the fill shall be brought up in approximately horizontal layers not to exceed 9 inches in thickness. Each layer shall be spread, processed, and shall be compacted by one of the following methods, as specified on the drawings:

Dozer - Complete coverage by tread or track of hauling or spreading equipment. Each lift shall not exceed 5 inches in thickness. Low ground pressure dozers may not be used for compaction.

Roller - two passes of standard tamping type roller over the entire area to be compacted. Complete coverage by the treads of loaded hauling equipment is considered equivalent to two (2) passes of tamping roller. Each lift shall not exceed 9 inches in thickness.

The tamping-type roller shall have tampers or feet projecting not less than six (6) inches from the surface of the drum and shall have a minimum static load on each tamper of 250 pounds per square inch of tamping area. Tamping rollers with minimum static load on each tamper of 125 pounds per square inch of tamping area may be used if the number of passes is increased to four (4) or the thickness of lifts is reduced to four (4) inches. (Sheepsfoot or wedgefoot drum rollers are considered tamping rollers.)

Levee shall be constructed to lines and grades shown on the drawings. Finish grade shall be smooth, uniform, and ready for seedbed preparation.

**Additional details:**

**Moisture control**

The moisture content of the fill material and foundation shall be such that the required compaction can be obtained. The minimum moisture content of fill material and foundation shall be such that when kneaded in the hand, the fill material will form a ball which does not readily separate. The maximum moisture content is when conditions are too wet for efficient use of the hauling and compaction equipment.

**Borrow areas**

All borrow areas shall be graded and left so they are protected from erosion and may be seeded. Borrow areas inside the pool area shall have side slopes of 4(H):1(V) or flatter.

**Vegetation**

Topsoil shall be added, if needed, to establish vegetation. Refer to JS-AGRON-25 for seeding and mulching recommendations or equivalent